

Quest 3: Chart Our Destiny in the Solar System

Goals:

- Understand the solar system forces and processes that affect the future habitability of Earth
- Find extraterrestrial resources of human interest
- Assess suitability of selected planetary locales for future human exploration

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The third fundamental Quest is to "Chart our Destiny in the Solar System." What is the future habitability of Earth and other planets? This requires that we understand the critical processes that affect the long-term evolution of the terrestrial biosphere.

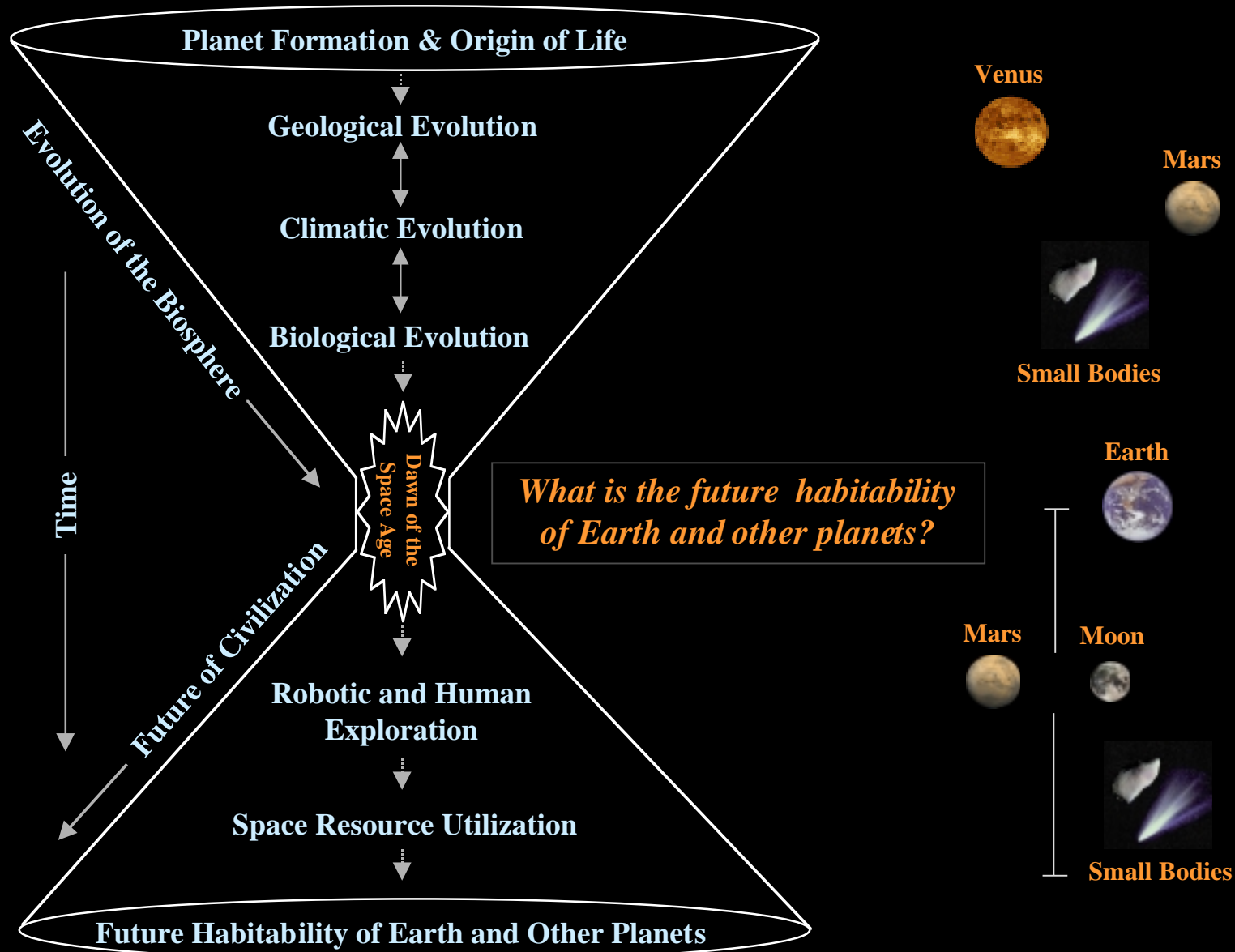
The formation of Earth and the origin of life set the stage for Earth's subsequent geological, climatic, and biological evolution. The dawn of the space age is the key event enabling humans to seek answers in the Solar System and a destiny beyond the Earth. As humanity explores the Solar System we learn about the potential evolutionary pathways open to Earth and we can develop models that help us predict its future. We also learn things we must know to protect Earth from the impacts of comets and asteroids, and we can begin making use of the resources available to us on other worlds or on Earth-approaching asteroids.

Biological evolution has been altered by mass extinction events caused by comet or asteroid impacts, so to understand and predict these events we need to better understand the number and nature of these objects.. Examples of global climate change in the solar system can help us to model Earth's long-term climate. And as human civilization begins to expand into the Solar System, robotic exploration of the Moon and Mars will help us determine what resources are present on these worlds that could enable a long-term human presence.

QUEST 3 - Chart our Destiny in the Solar System

Process

Key Destinations



Strategic Importance of the R&A Programs

Examples of contributions to Quest 3: Chart our destiny in the solar system

Planetary Geology and Geophysics

- Constrain the thermal evolution of solar system bodies
- Evaluate the history and evolution of planetary surfaces and atmospheres
- Model the role and effect of impact processes in planetary evolution

Cosmochemistry

- Acquire knowledge of surface materials and how to utilize them
- Document major terrestrial impact events
- Characterize the physical properties of small bodies that approach Earth

Planetary Astronomy

- Complete the inventory of near-Earth objects larger than 1 km

Planetary Atmospheres

- Chart the evolution of planetary atmospheres
- Understand the diverse characters of the terrestrial planet atmospheres

Astrobiology

- Address issues for the future of life on Earth and beyond
- Investigate the stability of closed artificial environments

Astrobiology and Solar System Exploration

How Quest 3 contributes to the study of life in the Universe

As we come to better know our planet, our planetary neighborhood, and how we came to be here, we will begin to be able to predict the evolutionary pathways open to our planet and ourselves. Many of the observable forces and phenomena at work in the solar system affect Earth as well, although from our terrestrial vantage point we cannot always measure them directly. An understanding of impact hazards, and the possibilities for mitigating them, is a potentially significant contribution of both ground-based and space-based solar system exploration. Comparative planetology allows us to place Earth in context; by studying the bodies in our solar system we can infer the behavior of Earth as a planet and thus understand its destiny as well as our own.

Our growing understanding of the Origins of the solar system and of life will in time allow us to identify those investigations for which human presence on other worlds is ultimately required. Coupled with our growing understanding of the physical characteristics and resources of the solar system, this will enable us to identify those places where humans might eventually live and work. We can then begin to understand how and why humans might leave planet Earth to fulfill a destiny in the solar system.

Astrobiology and Solar System Exploration

Quest 3: *Chart Our Destiny in the Solar System*

...helps to answer the last of Astrobiology's three Fundamental Questions:

What is life's future on Earth and beyond?

Exploration of the Solar System:

Goals for Quest 3

Future habitability of Earth

Extraterrestrial resources

Locales for human exploration

...address...

Astrobiology:

Goals

6.) Nature of habitable planets

and

9.) Ecosystem response to changes

6.) Nature of habitable planets

10.) Terrestrial life's response in
space or on other planets

EDUCATION & OUTREACH

Education and Outreach

One of the fundamental objectives of the Solar System Exploration program, as for the entire Space Science Enterprise, is to educate and inspire the public and especially our nation's youth. Exploration of the Solar System is intrinsically exciting and accessible to the public, since it deals with the bodies they can see in the night sky and the phenomena that affect planet Earth. We use these natural connections to bring scientists, educators, and the public together as we communicate the importance and excitement of exploration.

This section describes how we can use Solar System Exploration principles and results in the formal education of our young people. This is perhaps the most challenging but ultimately the most valuable contribution we can make to the future of our nation and of humanity. Our Quests can be directly related to benchmarks and learning standards for a variety of grade levels. The standards reflected here are national standards for science learning as recommended by the National Science Foundation; many states have adopted these standards for their schools. As new images and data appear over time, students who meet these standards will have a foundation of knowledge that will allow them to appreciate the significance of NASA's discoveries. Ultimately they will begin to develop their own views of Earth's place in the solar system as they grow into the scientists and leaders of tomorrow.

Infusing Education & Public Outreach into Space Science Programs

- E&PO gets infused into programs in different ways depending on whom we are trying to reach:

Public Outreach - Informal Education - Formal Education



- Public outreach and informal education are event driven - missions, encounters, launches, etc.
- Formal education uses solar system science to teach concepts and critical thinking.

Artwork in this section submitted by students to: <http://kids.msfc.nasa.gov/gallery/gallery.asp>

The Space Science Education and Public Outreach Ecosystem

The educational establishment is vast and NASA is small -
We seek to leverage our resources wherever possible to have maximum impact



Objectives:

- Bring together scientists and educators
- Guide and advise NASA scientists and managers
- Catalog and evaluate science educational material related to space science
- Relate educational material to state standards and benchmarks
- Direct educators and developers to content and educational resources

Science Education Standards and Benchmarks



- **Standards:** Describe what students should know and be able to do
 - **Benchmarks:** Grade-specific learning goals leading toward science literacy
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- Each state (and frequently each school district) has their own standards and benchmarks
 - There is broad consensus on benchmarks and standards within the scientific, mathematical, and educational communities.
 - Standards can be mapped into the objectives of each exploration quest



Solar System Exploration Quests

Address Related Education Content Standards:

- **Science Standard 1**
 - Understands basic features of the Earth
- **Science Standard 2**
 - Understands basic Earth processes
- **Science Standard 3**
 - Understands essential ideas about the composition and structure of the universe and the Earth's place in it
- **Science Standard 4**
 - Knows about the diversity and unity that characterize life



- **Science Standard 10**
 - Understands basic concepts about the structure and properties of matter
- **Science Standard 14**
 - Understands the nature of scientific knowledge
- **Science Standard 15**
 - Understands the nature of scientific inquiry
- **Technology Standard 3**
 - Understands the relationships among science, technology, society, and the individual

Quest 1- Explain the Formation and Evolution Of the Solar System and the Earth Within It

How do planets form?

Why are the planets different from one another?

- **Educational Standard:**

- Understands essential ideas about the composition and structure of the universe and the Earth's place in it

- **Educational Benchmark (Middle School Grade 6-8) S3.3.2**

- Knows that nine planets of differing sizes and surface features and with differing compositions move around the Sun in nearly circular orbits; some planets have a variety of moons and rings of particles orbiting around them (e.g. the Earth is orbited by one moon, many artificial satellites and debris)

- **Educational Benchmark (High School Grade 9-12) S3.4.2**

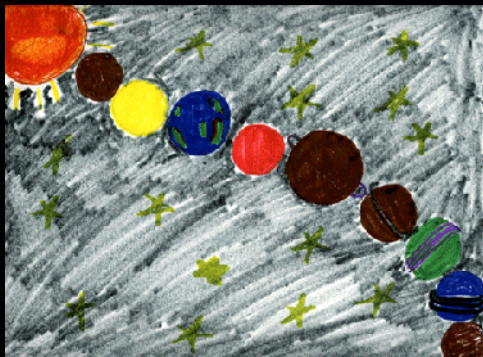
- Knows that at the beginning of the universe, stars formed out of clouds of the lightest elements and became hot as the material condensed and began releasing energy from the nuclear fusion of light elements into heavier ones in their extremely hot, dense cores; some stars eventually exploded, producing clouds of material from which other stars and planets would condense; this process of star formation and destruction continues

Quest 2- Seek the Origin of Life and Its Existence Beyond the Earth

Where did the makings of life come from?
Did life arise elsewhere in the solar system?

- **Educational Standard:**

- Understands essential ideas about the composition and structure of the universe and the Earth's place in it



- **Educational Benchmark (High School Grade 9-12) S3.4.4**

- Knows that life is adapted to conditions on Earth, including the strength of gravity to hold an adequate atmosphere and an intensity of radiation from the Sun that allows water to cycle between liquid and vapor

Quest 3 - Chart Our Destiny in the Solar System

What is the future habitability of Earth and the other planets?

- **Educational Standard:**
 - Understands essential ideas about the composition and structure of the universe and the Earth's place in it
- **Educational Benchmark (Middle School Grade 6-8) S3.3.5**
 - Knows that many pieces of rock and ice orbit our Sun: some meet the Earth in its orbit, glow and disintegrate from friction as they plunge through our atmosphere; other objects have long, off-center orbits that bring them close to the Sun, whose radiation boils off material and pushes it into a long, illuminated tail
- **Educational Benchmark (High School Grade 9-12) S3.4.5**
 - Knows that the scientific account of the universe comes from studying evidence about its contents and imagining, with the help of mathematical models and computer simulations, how the contents got to be the way they are